Living With a Star

http://lws.gsfc.nasa.gov

The LWS Missions are designed to develop scientific knowledge and understanding of those aspects of the Connected Sun-Earth system that directly affect life and society

Solar Dynamic Observatory (SDO)

Web Link: http://sdo.gsfc.nasa.gov

With the exception of the slow evolutionary changes in solar structure over the last 4.5 billion years, all solar variability is magnetic in origin. The solar cycle is a magnetic cycle in which the Sun's magnetic poles reverse with a periodicity of approximately 11 years, and intense magnetic fields erupt through the surface in sunspots whose numbers wax and wane with the cycle. Solar flares and coronal mass ejections occur when magnetic fields are stressed beyond their limits. The very structure of the corona and the solar wind is determined by the structure of the magnetic fields inside the Sun. The heating of the Sun's corona and the acceleration of the solar wind are thought to be due to interaction between small-scale magnetic elements. SDO will help us understand the mechanisms of solar variability by observing how the magnetic field is generated and structured and how this stored magnetic energy is released into the heliosphere and geospace.

SDO has four main goals:

1) Understand the Solar Activity Cycle. 2) Identify the role of the magnetic field in delivering energy to the solar atmosphere and its many layers. 3) Study how the outer regions of the Sun's atmosphere evolve over space and time - ranging from seconds to centuries. 4) Observe and characterize the radiation (e.g. UV, EUV, etc.) levels of solar output that affect the atmospheres of Earth, the planets, and all other bodies in the solar system.

SDO Instruments

SDO will carry a suite of instruments that will provide the observations needed for a more complete understanding of the solar dynamics that drive variability in the solar system.

Space Environment Testbeds (SET)

Web Link: http://lws-set.gsfc.nasa.gov

Goal: Improve the engineering approach to accommodate and/or mitigate the effects of solar variability on spacecraft design and operations so that new technologies can be infused into space missions without adding risk.

Approach:
1) Collect data in space to validate the performance of new technologies and instruments for LWS science missions; 2) Collect data in space to validate new and existing ground test protocols for the effects of solar variability on emerging technologies; 3) Develop validated engineering environment models, tools, and databases for spacecraft design and operations. These will reduce the requirements for margins needed to account for the uncertainties in our knowledge of the space environment in the presence of a spacecraft.

Sentinels Mission

The primary scientific objective of the LWS Sentinels element is to discover, understand, and model the connection between solar phenomena and interplanetary disturbances, particularly those impacting geospace.

The Sentinels scientific objectives provide a natural coupling between the solar and geospace segments of LWS. A Science Definition Team has recently (Fall 2004) been commissioned for the LWS Sentinels Mission, and their report should be completed in a year.

Living With a Star

We live in the extended atmosphere of a magnetically-variable star. While sunlight enables and sustains life, the Sun's variability produces streams of high-energy particles and radiation that can affect life.

Under the protective shield of a magnetic field and atmosphere, the Earth and the other bodies in the solar system are islands in the Universe. On Earth life has developed and flourished. The origins and fate of life on Earth are intimately connected to the way the Earth responds to the Sun's variations. Understanding the changing Sun and its effects on the Solar System, life, and society is the goal of the Sun-Earth Connection.

What is "Space Weather"?

Everyone is familiar with changes in the weather on Earth. But "weather" also occurs in space. Just as it affects weather on Earth, the Sun is responsible for disturbances in our space environment as well.

Besides emitting a continuous stream of plasma called the solar wind, the Sun periodically releases billions of tons of matter and magnetic fields in what are called coronal mass ejections (CMEs). These immense clouds of material, when directed towards Earth, can cause large geomagnetic storms in the magnetosphere and the upper atmosphere. They can also produce radiation hazards for robotic spacecraft and human explorers venturing into space.

The term space weather generally refers to conditions on the Sun and in the solar wind, as well as conditions in terrestrial and planetary magnetospheres, ionospheres, and thermospheres. Space weather conditions can influence the performance and reliability of space-borne and ground-based technological systems and can endanger human life or health.

LWS Objectives

Living With a Star is a cross-cutting program whose goals and objectives have links across NASA:

1) Space Science: LWS quantifies the physics, dynamics, and behavior of the Sun-Earth system over the 11-year solar cycle. 2) Earth Science: LWS improves understanding of the effects of solar variability and disturbances on terrestrial climate change. 3) Human Exploration and Development: LWS provides data and scientific understanding required for advanced warning of energetic particle events that affect the safety of robots and humans. 4) Aeronautics and Space Transportation: LWS provides detailed characterization of radiation environments useful in the design of more reliable electronic components for air and space transportation systems.

Geospace Missions

As society becomes increasingly dependent on space-based technologies, its vulnerability to space weather here, and at other planets, becomes ever more obvious. The need to understand and mitigate the effects of space weather is becoming urgent. The LWS Geospace Missions address these concerns with scientific investigations tailored to understand the characteristics of those regions in which space weather effects are particularly acute: (1) Earth's ionosphere and thermosphere, and (2) Earth's radiation belts.

Ionosphere-Thermosphere Storm Probes (ITSP)

In conjunction with an imager to be placed on a non-LWS high-altitude spacecraft, the LWS Geospace Missions will launch two spacecraft, the Ionosphere-Thermosphere Storm Probes, to survey the global distribution of ionospheric and thermospheric densities, ionospheric irregularities, and geomagnetic disturbances as a function of varying solar and geospace conditions. Amongst other parameters, the spacecraft will observe the composition, chemistry, density, and dynamics of the Earth's ionosphere and thermosphere. Research on these observations will enable the development of models that predict optimal frequencies for radio communications, communication disruptions, and intervals of enhanced geomagnetic activity. An improved knowledge of neutral densities within the thermosphere will help mission planners select spacecraft orbits with the least drag and greatest lifetimes.

Radiation Belt Storm Probes (RBSP)

Energetic ions and electrons within the Earth's radiation belts pose a hazard to both astronauts and spacecraft. The LWS Geospace Missions will launch two spacecraft, the Radiation Belt Storm Probes, to quantify the source, loss, and transport processes that generate the radiation belts and cause them to decay. One such loss mechanism is precipitation into the Earth's atmosphere, which endangers flight crews in high-altitude aircraft. Observations from the two spacecraft will enable the development of empirical and physics-based models for the radiation belts. The former will be used by engineers to design radiation-hardened spacecraft, while the latter will be used by forecasters to predict geomagnetic storms and alert both astronauts and spacecraft operators. The RBSP spacecraft will carry instruments capable of measuring the composition of the particles within the radiation belts.

LWS Targeted Research and Technology (TR&T)

Web Link: http://lws-trt.gsfc.nasa.gov

The LWS Targeted Research and Technology (TR&T) program provides a physics-based understanding of the integral system linking the Sun to the Earth, both directly and via the heliosphere, magnetosphere, and ionosphere. Research proposals from the scientific community are selected and funded on the basis of relevance to LWS objectives, likelihood of success, and the description of a credible set of deliverables. Research tasks include data analysis, theory and modeling, and the development of tools and methods (e.g. software). Research topics include the effects of radiation on astronauts and technology, and the effects of solar variations on the terrestrial climate.

NASA Resources for Educators

NASA On-Line Resources for Educators provides current educational information and instructional resource materials to teachers, faculty, and students. A wide range of information is available, including science, mathematics, engineering, and technology education lesson plans, historical information related to the aeronautics and space program, current status reports on NASA projects, news releases, information on NASA educational programs, useful software and graphics files. Educators and students can also use NASA resources as learning tools to explore the Internet, accessing information about educational grants, interacting with other schools which are already on-line, and participating in on-line interactive projects, communicating with NASA scientists, engineers, and other team members to experience the excitement of real NASA projects.

Access these resources through the NASA Education Home Page: *http://www.hq.nasa.gov/education*

Websites For More Information

http://lws.gsfc.nasa.gov - The Living With a Star website. The website has links to the program's missions as well as news concerning them. It's a great place to keep up-to-date on the connected Sun-Earth system's research.

http://stargazer.gsfc.nasa.gov - Stargazers is a site designed for Education and Public Outreach. There is information for educators and students with news about Living With a Star and resources related to the connected Sun-Earth system, multimedia, photos, activities, and more. Both students and educators can also find information regarding Internships and Professional Development. Stargazers reaches a wide audience by being bilingual - Spanish and English.

http://lws-trt.gsfc.nasa.gov
http://sdo.gsfc.nasa.gov
http://lws-set.gsfc.nasa.gov
http://lws.gsfc.nasa.gov

Definitions

Corona	The very hot outer layer of the Sun's atmosphere, composed of highly diffused, superheated, iodized gases, and extending into interplanetary space. The hot gases in the solar corona from the solar wind.
Coronal Mass Ejection(CME)	A magnetic cloud of dense solar wind propagating away from the Sun.
Electromagnetic Spectrum	The array of electromagnetic radiation, arranged in order of wavelength from radio to gamma rays. Also refers to a narrower band of wavelengths, called the visible spectrum, as when light dispersed by a prism shows its component colors. Spectra are often striped with emission or absorption lines, which can be examined to reveal the composition and motion of the light source.
Heliosphere	The vast region starting at the Sun's surface and extending to the limits of the solar system, well beyond the orbits of the most distant planets.
Ionosphere	The region of a planet's atmosphere that on Earth extends from about 50 to 300 miles above the surface of the planet and is made up of multiple layers dominated by electrically charged or ionized atoms.
Magnetosphere	The outermost environment of a planet with an intrinsic magnetic field.For Earth the magnetosphere is the site of the radiation belt and many intricate phenomena. The magnetosphere is a cavity carved out of the extended atmosphere of the sun - the solar wind.

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